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Research Article

The Flood Simulation System as a New Process for Public Participation of Local Administrative Organizations in Tha Wang Pha District, Nan Province

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Abstract: This research paper discusses the new process for public participation of 7 local administrative organizations in Tha Wang Pha District, Nan Province in preparedness for flooding situation. Activities for the knowledge and technology transfer of a flood simulation system were conducted and attended by 50 invited representatives, who were presented with 5 questionnaires to test their acquired knowledge and skills. The willingness to apply the knowledge and skills to flood situation preparedness of their workplace or missions was analyzed through sub-questions and illustrated in a series of tables. The results showed that the contents of the knowledge sharing were comprehended between 82-90%. Following the technological workshop, the participants planned to use the knowledge to flood preparedness at 100% with measured skills at 100%. The paper concluded that 100% of the respondents agreed with the use of the flood simulation system in terms of building cooperation upon the knowledge and technology exposure, collaboration with relevant agencies, and support for the implementation of the flood simulation system. The official coordination of agencies and institutes was the key for the successfully organized activities, thus be it the new process for the focus-group public participation of local administrative organizations.

1. Introduction

Situated between mountains running North-South, the area of Tha Wang Pha District, Nan Province, is a basin (Figure 1 left) in the north of Nan Province that supports the whole Nan River flowing downwards and into the Chao Phraya River. Therefore, the study area about 60.83 sq.km. of Tha Wang Pha District (Figure 1 right) is the first lowland area, painted in blue representing frequent flooding risk. Recurring flooding problems in Tha Wang Pha District directly and indirectly affect 50,519 people, for example, the Kon Son Tropical Storm in 2010 affecting 2,437 people in 5 villages, from heavy rains on 7 August 2011. Soil and mud flood kept villagers stranded and unable to lift electrical appliances, vehicles and agricultural equipment to higher ground. There were also landslides and fallen trees blocking the road in Ban Sop Khun - Doi Tiw and Ban San Charoen, making villagers of more than 6 villages unable to pass through.

Government officials in Tha Wang Pha District recognize the importance of encouraging people and localities to take care of themselves. However, as far as the discussion with authorities in the district was concerned, access to the technology that helps local communities to prepare for and deal with the flood situation has never been provided. This paper gives the aspect of the people willingness to adopt the flood simulation system already delivered to a military unit in the area rather than tries to deliberately explain the creation of the system itself. The flood simulation system was used as a medium for activities of transferring the knowledge and technology and technical workshop in order to study a new process for the invited and focus-group participation of 7 local administrative organizations in Tha Wang Pha District, Nan Province.

Banks (1998) defined simulation as the imitation of the operating of a real-world process or system over time to describe

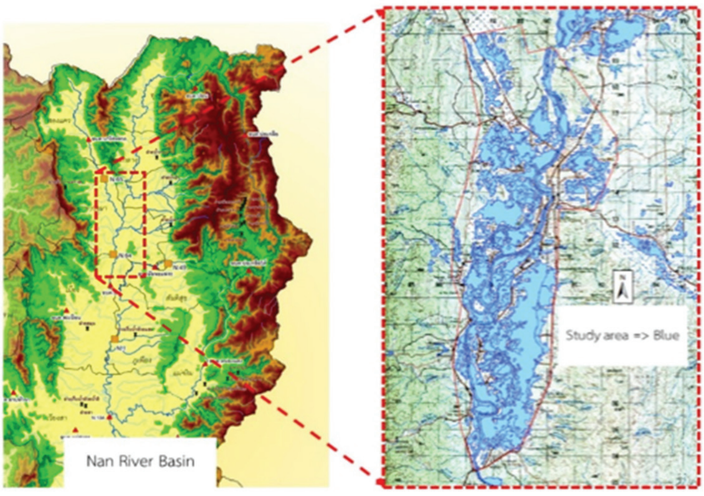

Figure 1. Nan River Basin (left) and study area (right)

and analyze the behavior of the system, ask what-if questions about a real system, and aid in the design of real systems. The flood simulation system in this study was developed to imitate real flooding situations in which its users can simulate a what-if-the-flood-level-was-x.xx-meters-from-a-reference-station question and realize the damage the people might anticipate, that is, simulating to achieve subjective goals. Balci (1998) stated that the reason for subjectivity was twofold: modelling was an art and credibility assessment was situation dependent, and further required that a unifying approach to measure qualitative as well as quantitative aspects of a simulation be studied. Since the public participation in this study was to include various decision making groups, the results needed to constitute a form of supporting their decision making. Following the work of Musselman (1998) closely, the activities detailed in this paper were to reflect how comprehensive the decision makers were towards their results when the welfare of the people of Tha Wang Pha District was at stake amidst flooding situations.

This research paper described the knowledge and technology transfer of the flood simulation system which was the product of the cooperation between Defence Technology Institute and Chiang Mai University, previously delivered to Mobile Development Unit 31 in Nan Province. Literature review on public participation and significant leadership coordination during emerging incidents was emphasized and on remote sensing and GIS for a reliable simulation system was sampled. The activities to transfer knowledge and technology on the flood simulation system to 7 local administrative organizations in Tha Wang Pha District and Nan Provincial Office of Disaster Prevention and Mitigation, Chiang Klang Branch was presented by the proposed methodology. The flood simulation system was demonstrated with its founding knowledge bodies, being both creditable advocacy and delivered knowledge contents. Processes to arrive at the dashboard was presented in a cartographic modelling diagram. The activities and their results were summarized and discussed towards the end of the paper. Conclusion and recommendations were provided at the end.

2. Related Work

Disasters have an impact on the life of communities. Negative effects lead many communities to engage in disaster mitigation, for example Cambria, Ca. The study of Lucett (2002) revealed the treatments (chipping, limbing, invasive species removal, and prescribed fire) that were accepted in the community of Cambria as well as identifying common areas of management priorities among Cambrians. Yeo & Comfort (2017) examined the structural characteristics of large-scale, inter-sector and multi-jurisdictional flood response coordination during the 2011 Thailand floods and identified three major gaps including the highly fragmented coordination structure, the poorly leveraged inter-sector relationships, and the weak liaison of provincial organizations to serve upper and lower actors. As the literature suggested, the flood simulation system was, then, used as the medium of coordination in this research paper.

Duan *et al*. (2020) employed a structural equation model to study the influencing factors of public participation in the meteorological disaster prevention and mitigation. They found that the behavior of the government had a significant positive influence on the public's participative willingness. When it came to individual response to disaster prevention and mitigation, Abdulkasan *et al*. (2021) determined the extent of participation among citizens of Cotabato City, Philippines in five participation goals: inform, consult, involve, collaborate, and empower. Conclusively, government, community and down to individual participation played an important role in disaster management. Thus, there was the need to study for the process that every engaging party would participate to anticipate successful disaster prevention and mitigation, and this paper tried to respond to that need.

To meet the complex needs of vulnerable populations, Adams *et al*. (2022) developed a free online course to draw on decades of research to examine the factors that influenced social vulnerability to disasters. Back in 2007, Bryman stated that the widely held principle of social research was questionable as a representation of social research practice. Ismail & Zubairi (2022) examined the content validity evidence of an instrument to measure the reading ability of university students using Item Objective Congruence (IOC) analysis. Therefore, this current research for public participation included formulating questionnaires that underwent the IOC analysis for questionnaire liability.

Gultom (2016) investigated how the culture and network ties of an affected community encouraged trust and participation in disaster communication. Kamarudin *et al*. (2018) explained one of 5 strategic results for disaster risk reduction from focus group discussion was to improve the level of cooperation and risk communication between agencies to identify victims' status, facilities/property affected or damaged during the disaster. Hsu (2017) examined village heads' information seeking and decision making in 2014 Kaohsiung Blast and found that they received regular disaster trainings but acted like lay people during the incident. To sum up, with the increasingly common occurrence of unprecedented disasters, researchers and practitioners need to study how community leaders reacted differently to different disasters and how their authority, knowledge, and social capital interacted.

Recently, Marchezini *et al*. (2022) aimed to identify gaps and the potentialities of citizen-generated data in an international virtual dialogue that engaged 40 public servants, practitioners, academics and policymakers from Brazilian and British hazard and risk monitoring agencies during the Covid-19 pandemic. The common challenges identified were lack of local data, data integration systems, data visualization tools and lack of communication between flood agencies. Tamang *et al*. (2014) introduced a method to predict the area vulnerable to flood and integrated MIKE 11 GIS to provide surface geometry modeling. Bibi, Nawaz, & Abdul (2018) reported that the Union Council Agra in Pakistan vulnerability to flood hazard was due mainly to its geographical location and the lack of pre-disaster preparedness activities. There was an immense need of prevention and mitigation measure as floods were frequently occurring disaster in the area.

Khamutova *et al*. (2021) presented main components, models and methods of forecasting and the structure of a typical flood monitoring and forecasting system. The simulation results provided a more complete picture of the flood development in the dynamics and allowed decision makers to plan actions aimed at preventing and eliminating the effects of floods made effectively. Samdaengchai *et al*. (2022) analyzed disasters caused by flood via data from Sentinel-1 Satellite in Sukhothai Province, Thailand. At this provincial level, data on flood analyzed from optical data was at flood areas of 106.632 sq.km. and at 96.751 sq.km. from radar Sentinel-1 Satellite at around 9.593% difference. More criteria on sensors, acquisition time, to name a few, needed intensive consideration if accurate flooded area results were anticipated.

van den Bout *et al*. (2023) explained FastFlood model with the potential to alter the field of flood modelling. It showed two orders of magnitude of increase in simulation speed, while obtaining highly similar accuracy as full dynamic models in presented case studies. With the reported increase in simulation speed, many avenues of research and application might be unlocked, from ensemble modelling for uncertainty, user-interactivity in web interfaces, or real-time modelling of large areas in early warning systems. However, the report reminded research communities to note that the aim of the FastFlood method was not to provide the most accurate flood hazard prediction and not with fine resolution. Therefore, the validity of the underlying assumptions were more focused to risk reduction planning or early warning at a large flooded area extent.

3. Method and Materials

3.1 Method

The flood simulation system was the product of the agreement between Defence Technology Institute and Chiang Mai University institutionalized cooperation already delivered to Mobile Development Unit 3 and was affirmative upon military acceptance for use. In 2021, data collection included UAV terrain modelling, ground survey for construction, buildings and seasonal agricultural products, making the data for damage assessment dashboard with GIS analysis an obvious and temporal drawback.

The understanding of the system provided by bodies of knowledge and technology underlying the system was seen as the key to open the door to local administrative acceptance. Therefore, it is hypothetical that knowledge and technology transfer activities of the flooding simulation system will gain acceptance from representatives of invited local administrative organizations to embrace the system as the tool for flood situation preparedness and risk reduction and also bring a new process for focus-group public participation of the invited local administrative organizations.

The research methodology for the knowledge and technology transfer of flood simulation system is illustrated in Figure 2. It is a target group-participatory approach. There were two frameworks in the activities. Framework 1: knowledge sharing among researchers from DTI, Chiang Mai University and officials of Chiang Klang Branch for a common understanding of the flood simulation system. The bodies of knowledge to share included field survey, terrain modelling with unmanned aerial vehicle, creation of a geo-spatial database, creation of 3D common operating picture, damage assessment from flood situations, and creation of a dashboard to support damage assessment from flood situations. Framework 2: technological workshop to transfer technology from the researchers to the officials of Chiang Klang Branch and representatives of the 7 local government organizations. Questionnaires were used to assess skills of the target groups capable of, for example, locating each flooded house in the system, and checking how the house/property is damaged when simulating the flood level x meters high from the reference station.

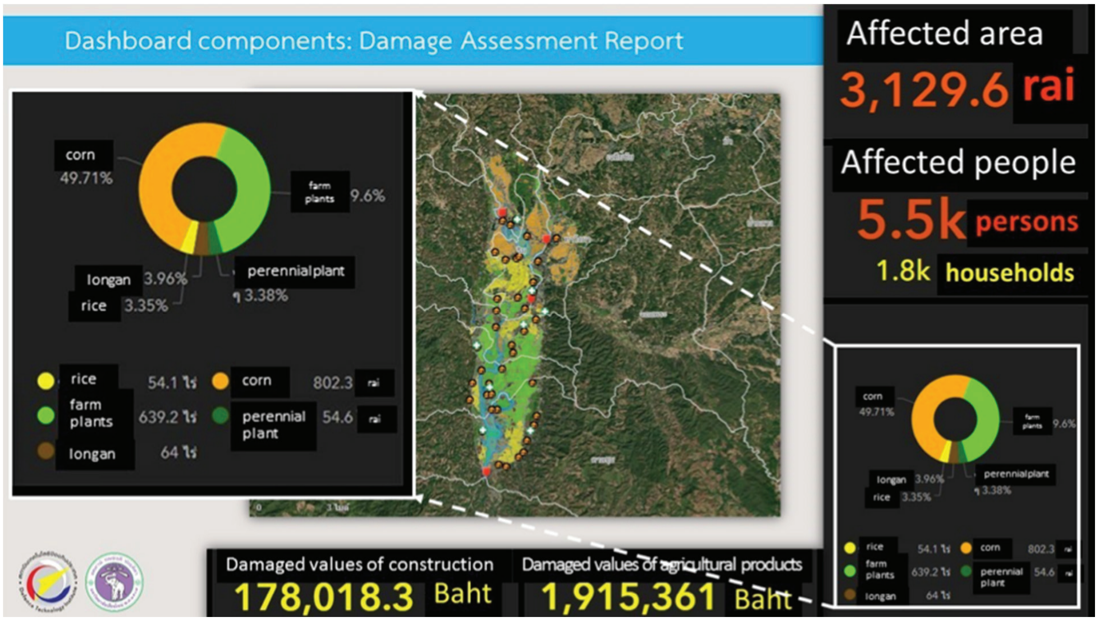

Figure 2. The research methodology flow chart

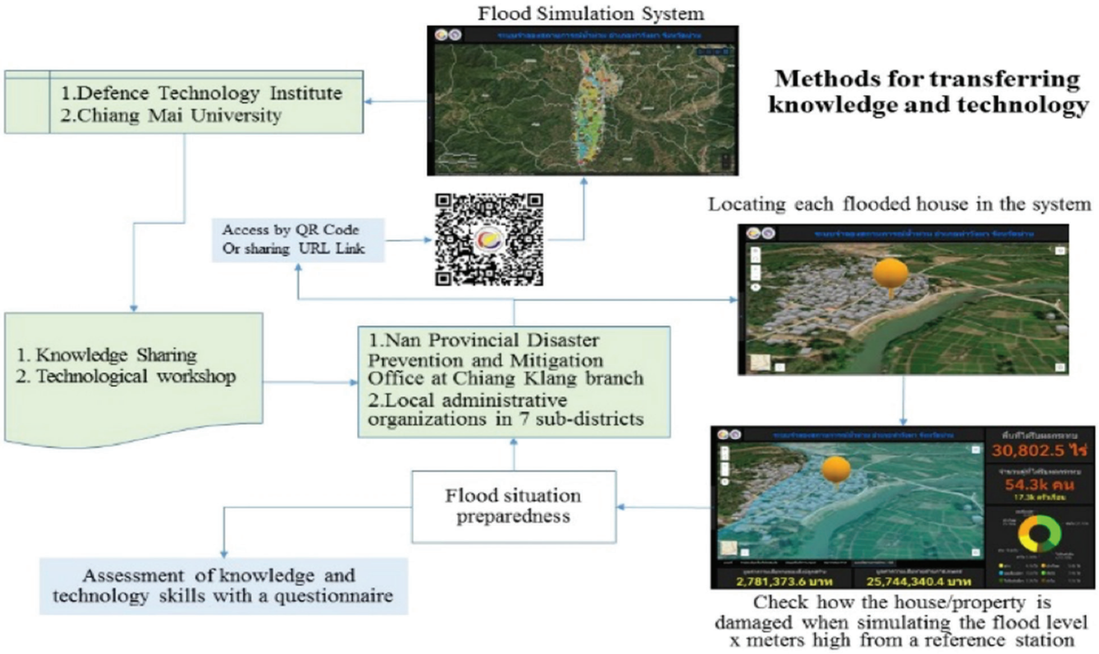

Figure 3. The flood simulation system dashboard

3.2 Materials

3.2.1 The Flood Simulation System

The flood simulation system for Tha Wang Pha District, Nan Province, was the product from the application of the knowledge shared in Framework 1 to the local officials of Chiang Klang Branch and the 7 sub-district administrative organizations of Tha Wang Pha District, Nan Province consisting of 10 villages of Tan Chum, 9 villages of Rim, 8 villages of Si Phum, 7 villages of Tha Wang Pha, 5 villages of Pa Kha, 2 villages of Pha Tor, and 2 villages of Saen Thong.

The flood simulation system made available by ArcGIS online as shown in Figure 3 consists of three main components: 1) toolbar shown as the left dotted box of Figure 3 working in conjunction with map display and links commands to display flood level simulation, agricultural activity data, water level reference stations, village locations, and administrative data; 2) map component shown as the middle dotted box of Figure 3 for controlling the display of 2D/3D maps, details of affected villagers, agricultural data, and weather forecast; and 3) damage assessment providing the analysis of the area and the simulation of flood level by determining the water level in the situation at every input 20 cm. interval from reference stations of the Nan River. This information was used to analyze the flood situation effecting buildings and agricultural areas. The value of the building and its assets, and the crop yield per rai and the value were calculated for damage assessment, as shown in the enlarged inset on the left of Figure 3.

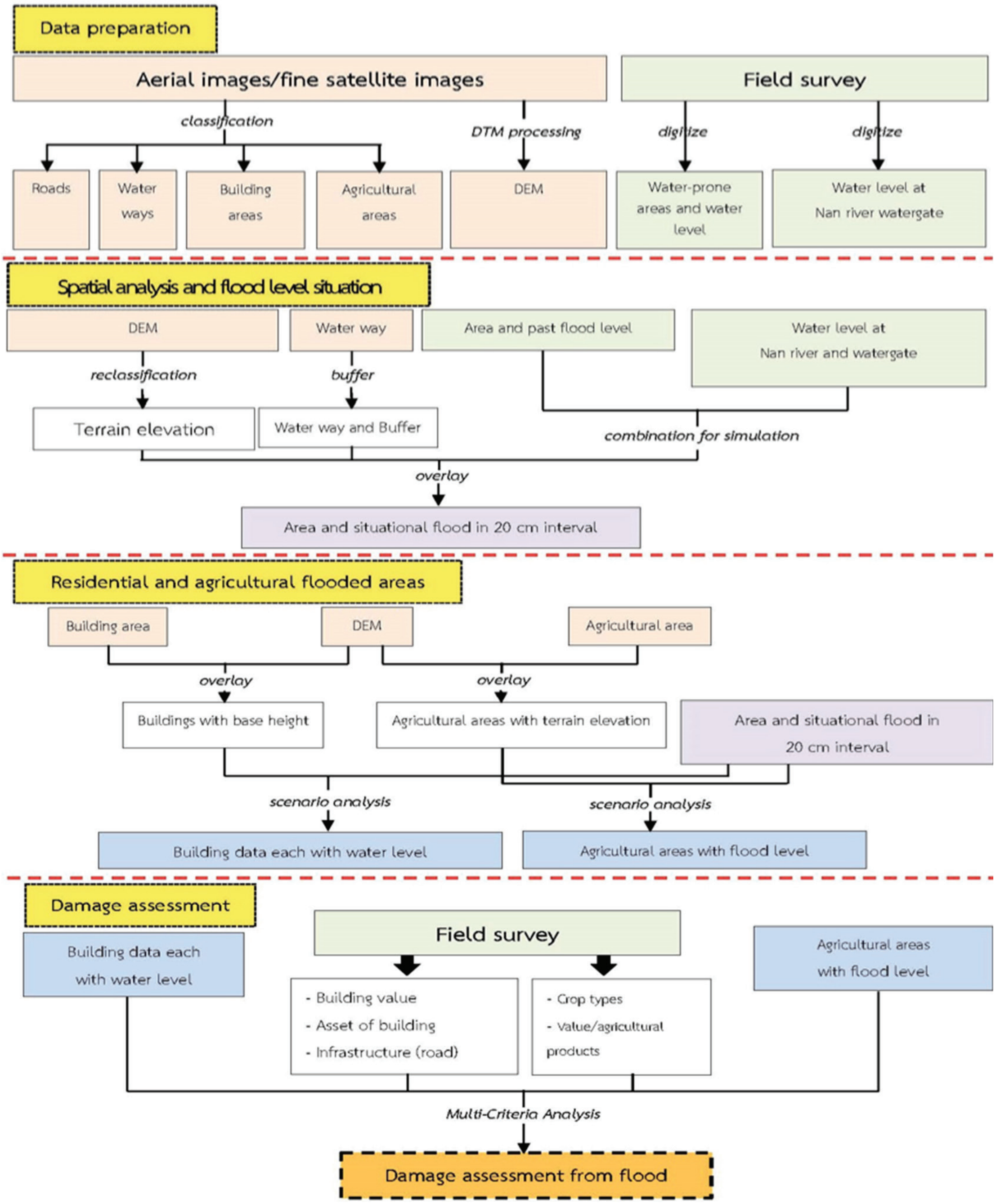

Figure 4. Cartographic modelling for the dashboard

3.2.2 Cartographic Modelling for Damage Assessment Dashboard

The dashboard creation illustrated in Figure 4 was a novel cartographic modelling diagram that consisted of 4 main steps towards the damage assessment tool. In data preparation, the study area was first acquired by UAV at 10 m. resolution with equal positional accuracy to ASPRS standard 1:500 map of no less than 0.125 m. This UAV terrain modelling yielded 10 cm ortho-imagery with horizontal and vertical accuracy of no less than 8 cm. and 15 cm. respectively, allowing the spatial analysis for contour intervals of 20 cm. as incremental flood simulation levels. Residential and agricultural areas were thoroughly surveyed to accommodate accurate and real values in 2021 and to attain reliable and verifiable flooding scenario analysis. Damage assessment values, for example, rice at 1,113 baht/rai and house each at 49,500 baht, followed guidelines for the damage assessment of Ministry of Agriculture and Cooperatives regarding flood-caused damages.

3.2.3 Questionnaire

Questionnaires were to respond to the designed frameworks where questionnaire no.1 tried to create the common understanding towards the system and questionnaire no. 2 tried to assess skills of the target groups in linking the acquired knowledge to utilization of the system for trial use. Ratings were set from the most (5), much (4), moderate (3), little (2), and the least (1). Purposely, the questionnaire no.1 was to assess the anticipation of the knowledge sharing that included the knowledge and skills of each training topic both before and after the training and most importantly on applying the knowledge to prepare for flood situations, the questionnaire no. 2 was to collect technological details of the flood simulation system that the target group received before and after the workshop.

3.2.4 Index of Item Objective Congruence (IOC)

The questionnaires were presented to 5 experts to determine content validity, the index of consistency between questions and the objectives or IOC; being 1 interpreted as consistent with the objectives, 0 as uncertain and -1 as inconsistent with the objectives. The IOC was calculated by:

$$\mathrm{IOC} = \frac{\sum_{i=1}^{n} R}{N} \qquad (1)$$

where IOC = Index of Item-Objective Congruence, $\sum_{i=1}^{n} R$ = sum of the scores for question 1 to question n, and N = the number of experts.

The IOC calculation gave all questions to each arrive at greater than 0.5, whereby the IOC for each questionnaire must be ≥ 0.5 to ensure the questionnaire meet the desired content and fit for use in the questionnaire.

3.2.5 Manual of the Flood Simulation System

The manual was provided in form of a tab on the ArcGIS online map engine with sections of introducing the toolbar section within the dashboard, flood elevation simulation, detailed display of agricultural data, water level station location information, village location information, jurisdiction information, weather information, using toolbars within the map, and dashboard map section. It also included data needed to answer the questions indicated in the questionnaires. Copies of the manual were also distributed at the activities of knowledge sharing, technological workshop, and focus group apart from the QR code or URL.

4. Experimental Results

4.1 Knowledge Sharing

The activity was held on 13 – 14 June 2023 at Si Phum sub-district conference center for 50 experts and authorities from the 7 invited sub-districts. The results of before and after knowledge sharing was summarized in Table 1. The result on field survey showed the knowledge of the respondents on the subject. Before the event participation, there was no respondent with the most, 5 respondents with much, 32 respondents with moderate, and 13 respondents with little and least knowledge and skills. After participating the activity, 5 respondents had the most level of knowledge and skill, respondents with increased knowledge and skills rising up to 40, and 5 respondents had the moderate level of knowledge and skills. Therefore, it can be seen that 45 out of 50 of the respondents had knowledge and skill on the field survey at the most and much levels or at 90%.

On UAV based terrain modeling, Table 1 shows 1 respondent with much knowledge and skill, 29 respondents with moderate knowledge and skill, and 20 respondents with little and least knowledge and skill. Upon the activity participation, the Table shows 1 respondent with the most knowledge and skill, 40 respondents at the much, and 9 respondents on the moderate level. Totally, 82% of the respondents had the knowledge and skill at most and much levels.

For geo-spatial database creation, Table 1 shows no respondents were with the most level, only 2 persons with much level, 33 persons with moderate level, and 15 respondents with little and least level. After the activity ended, the Table shows 2 persons were at the most level, 42 persons at the much level, and 6 persons at the moderate level. Therefore, 88% of the respondents

Table 1. Summary of before and after knowledge sharing

Shared knowledge bodies	Knowledge on the topic before the knowledge sharing					Knowledge on the topic after the knowledge sharing				
	Most	Much	Moderate	Little	least	Most	Much	Moderate	Little	least
Field survey	-	5	32	12	1	5	40	5	-	-
UAV based terrain modeling	-	1	29	12	8	1	40	9	-	-
Geo-spatial database creation	-	2	33	12	3	2	42	6	-	-
Flood damage assessment and dashboard creation	-	1	39	9	1	2	41	7	-	-

had the knowledge and skill at the most and much levels.

Table 1 shows the results on flood damage assessment and dashboard creation. Before participating in the event, there was no person with the most knowledge and skill, only 1 person with the much level, 39 persons with the moderate level, and 10 persons with the little and least levels. After the activity ended, the Table shows that 2 persons were with the most level, 41 persons with the much level, and 7 persons with the moderate level, making 86 percent with the much and most levels.

4.2 Plan to Apply the Knowledge and Skills to Flood Situation Preparedness

On questionnaire questions of how the participants planned to apply the gained knowledge and skills, Table 2 shows that 13 persons were ready at the most level, 31 persons at the much level and 6 persons at the moderate level. Therefore, the participants were able to apply the gained knowledge and skills at 88 percent. For their own use, the Table says that 14 persons were able to at the most level, 29 at the much level, and 7 persons at the moderate level, meaning that the participants were able to use the received knowledge and skills at 86 percent. Finally, Table 2 says that 14 persons were able to disseminate the acquired knowledge and skills to their agencies with 29 and 7 persons at the much level and moderate level, respectively. Therefore, 86 percent of the participants were able to disseminate knowledge/transfer to their agencies at the most and much levels.

4.3 Technological Workshop

Four questions on the use of the dashboard were as follows: 1) determining reference station to increment the flood level; 2) inputting house or building coordinates in the study area on the system; 3) investigating the value of damaged buildings and agricultural areas; and 4) checking the number of affected people in the area. The measured numbers are summarized in Table 3.

With the measured skill to determine reference station to increment the flood level, Table 3 shows one respondent with the most, 7 with the much, 17 with the moderate, 21 with the little, and 4 with the least level,

Table 2. Summary of plan to use the knowledge to flood preparedness

Knowledge application	Knowledge on the topic before the knowledge sharing				
	Most	Much	Moderate	Little	least
Work back in office	13	31	6	-	-
Apply for own use	14	29	7	-	-
Disseminate/transfer further	14	29	7	-	-

Table 3. Summary of measured skills

Activities	Levels of measured skill				
	Most	Much	Moderate	Little	least
Determining reference station					
Before workshop	1	7	17	21	4
After workshop	13	29	8	-	-
Inputting coordinates					
Before workshop	-	8	17	21	4
After workshop	12	32	6	-	-
Investigating values					
Before workshop	-	9	14	24	3
After workshop	14	30	6	-	-
Checking the number of affected people					
Before workshop	-	7	17	23	3
After workshop	15	30	5	-	-

meaning that 50 percent of the respondents having the little or least levels.

However, the Table shows 13 respondents having the most level with 29 having the much level, 8 having the moderate level, and no respondents with the little or least level after the workshop. Therefore, the respondents, at least, were able to set a reference station at the moderate level after the activity.

For the skill to input house or building coordinates of the study area on the system, the Table reveals 8 respondents with the much, 17 with the moderate, 21 with the little, and 4 with the least level, meaning that 50 percent of the respondents having the little or least levels. But after the workshop, the Table says 12 respondents having the most level, 32 having the much level, 6 having the moderate level, and none having the little or least level, meaning that the respondents, at least, were able to input house or building coordinates of the study area on the system at the moderate level.

With the skill to investigate the value of damaged buildings and agricultural areas, the Table shows none with the most knowledge and skills, 9 with the much level, 14 with the moderate level, 24 with the little, and 3 with the least level, meaning that 54 percent of the respondents having little or least knowledge and skills. But after the workshop, the Table says 14 respondents having the most level, 30 having the much level, 6 having the moderate level, and none having little or least level, meaning that the technical training allowed the respondents to, at least, detect the damage to buildings and agricultural areas at the moderate level.

For the skill to check the number of affected people in the area, Table 3 has no respondents with the most knowledge and skills, 7 with the much level, 17 with the moderate level, 23 with the little level, and 3 with the least level, meaning that more than 50 percent of the respondents having little but no least knowledge and skills. But after the workshop, the Table shows 15 respondents having the most level, 30 having the much level, 5 having the moderate level, and none having the little nor least level, meaning that the flood simulation system enabled the respondents to monitor the number of affected people in the area, at least, at the moderate level.

4.4 Collaborative Workshop

To assess the attitude of the respondents to embrace the flood simulation system in their work routine for collaboration among local administrative organizations, the questionnaire was designed to evaluate the results in terms of building cooperation on the acquired knowledge and technology, the collaboration of engaged agencies, and the support for implementation of the system.

4.4.1 To Embrace the System for Building Cooperation on the Acquired Knowledge and Technology

Table 4 shows the prospect of how cooperatively the respondents reacted when exposed to the knowledge and technology. There were sub-questions to extract on the point of the respondents using the internet to find information about floods and other disasters. Ten respondents rated most to

Table 4. Summary of cooperating the acquired knowledge and technology

Cooperative activities	Levels of agreement				
	Most	Much	Moderate	Little	least
Using the internet for information about floods and other disasters	10	33	6	1	-
Information obtained from internet to help make decisions	12	27	11	-	-
Technology and information used in dealing with flood situations/other disasters	2	26	21	1	-
Technology to deal with the flood situation and reduce the damage to the people	22	22	6	-	-

the question, 33 gave much for an answer, 6 gave moderate for an answer, and 1 gave least for an answer. The result shows that 98 percent of the respondents used the internet to search for information about flood situation and other disasters. Therefore, the internet played a key role on reaching out to an outside source.

The second cooperative activity was measured on how useful the respondents viewed on the information obtained from internet searches that would help make decisions. Twelve respondents gave most for an answer, 27 gave much for an answer, and 11 responded moderately. The Table shows that 100 percent of the respondents used the information obtained from internet searches to make decisions with the plan to deal with various flood/disaster situations.

For the question of technology and information from the internet being used in dealing with flood situations/other disasters, two respondents gave most for an answer, 26 respondents gave much for an answer, 21 persons gave moderate for an answer, and only 1 person gave the least for an answer. The Table shows that 98 percent of the respondents in use of the technology and information from the internet were able to say useful in dealing with flood situations/other disasters.

For the question of whether the technology could help the respondents plan to deal with the flood situation to help reduce the damage to the people, 22 respondents gave most for an answer, 22 persons gave much for an answer, and 6 respondents gave moderate to the answer. The Table also shows that 100 percent of the respondents believed technology could help the respondents plan to deal with the flood situation to help reduce the damage to the people.

4.4.2 To Build Cooperation on the Acquired Knowledge and Technology

Table 5 shows the prospect of how the respondents build cooperation on the acquired knowledge and technology. There were sub-questions to show how they built such cooperation.

To cherish network and cooperation with stakeholders or other relevant agencies, the respondents would request assistance from relevant agencies when a flood situation took place. Twelve respondents gave most for an answer, 32 gave much for an answer, and 6 gave moderate for an answer. The Table shows that no respondents or responsible agencies worked alone during the flood situation.

The Table shows a strong tie of the respondents with other local government agencies. Nineteen respondents gave most for an answer, 28 gave much for an answer, and 3 gave moderate for an answer. It reveals that 100 percent of the respondents agreed that their agencies had good relationships with other government agencies.

Table 5. Summary of building cooperation on the acquired knowledge and technology

Building cooperation activities	Levels of agreement				
	Most	Much	Moderate	Little	least
Requesting assistance from relevant agencies	12	32	6	-	-
Strong tie of the respondents with other local government agencies	19	28	3	-	-
Having a network of cooperation to provide help for each other	9	36	5	-	-
Dealing with flood situation demanding the cooperation of many agencies	17	31	2	-	-

From Table 5, it shows whether the agencies of respondents had a network of cooperation to provide help for each other when flooding occurs. Nine respondents gave most for an answer, 36 persons gave much for an answer, and 5 persons gave moderate for an answer. They all agreed that the agencies had a network of cooperation to help each other when flooding occurred.

Finally, the Table shows whether the agencies of respondents dealt with the flood situation by demanding the cooperation of many agencies. Seventeen respondents gave most for an answer, 31 gave much for an answer, and 2 gave moderate for an answer. They all agreed that coping with the flood situation required the cooperation of many agencies.

4.4.3 To Support the Implementation of the Flood Simulation System

Table 6 summarizes the encouragement of the respondents to use the system to cope with flooding or other disasters. It shows good encouragement of the respondent agencies to use modern technology to cope with flooding or other disasters. Ten respondents gave most for an answer, 18 respondents gave much for an answer, and 22 respondents gave moderate for an answer. Most of them agreed that the activities encouraged them to use the technology in dealing with flood situations or other disasters.

The Table reveals the respondents' support of having devices or technologies and in support of the use of technology. Only 1 respondent gave most for an answer, 20 gave much for an answer, 20 gave moderate for an answer and 9 gave little for an answer. Thus, the respondents believed that there were devices and technology for disaster management and supported the use of technology.

The Table shows the ability of the respondents to share the flood simulation technology with others. Two respondents gave most for an answer, 37 respondents gave a much for an answer, and 11 respondents gave a moderate for an answer. Assumedly, the respondents were certain to distribute the flood simulation system to others.

The Table shows respondents' willingness to recommend/transfer the flood simulation system to others. Five respondents gave most for an answer, 39 respondents gave much for an answer, and 6 respondents gave moderate for an answer. It can be anticipated that the flood simulation system will be recommended/transferred to others.

Table 6 also shows the respondents' view of whether the flood simulation system could help to reduce the loss/damage from the flood situation. Seventeen respondents gave most for an answer, 33 gave much for an answer. Therefore, 100 percent of the respondents agreed that the flood simulation system could reduce the loss/damage of flooding situations.

Finally, Table 6 shows if the respondents thought that the simulation system was useful for planning for flooding. Seventeen respondents gave most for an answer, 27 respondents gave much for an answer, and 6 respondents gave moderate for an answer. Therefore, 100% of the respondents agreed that when the flood situation occurred, the flood simulation system was useful for planning for flooding situations.

Therefore, it can be concluded from the summary of Table 6 that 100% of the respondents agreed with the use of the flood simulation system in terms of building cooperation through knowledge and technology exposure, collaboration with relevant agencies, and support for the implementation of the system.

Table 6. Summary of the support for use of the system to cope with flooding or other disasters

Activities of supporting the use of the system	Levels of support				
	Most	Much	Moderate	Little	least
Encouragement to use modern technology to cope with flooding or other disasters	10	18	22	-	-
Having devices or technologies and supporting the use of technology	1	20	20	9	-
Ability to share the flood simulation technology with others	2	37	11	-	-
Recommending/transferring the flood simulation system to others	5	39	6	-	-
The system helped to reduce the loss/damage from the flood situation	17	33	-	-	-
The system was useful for planning for flooding	17	27	6	-	-

5. Discussion

Table 7 gives the results in percentage of after knowledge and technology transfer activities for focus-group public participation. Where the acquired knowledge was concerned, only much and most levels were cited as significant for the following activities and deemed crucial to the decisiveness to embrace the technology for later routine use. Where technological and technical skills were involved, the moderate up to most level were summed up in the Table, given just a few day activities but that much picked up technical skill. Answers for sub-questions as seen in the last three rows of the Table were in an overall.

From Table 7, the knowledge sharing was considered a success. The knowledge of the respondents after attending the activity on field survey was rated 90% at most and much levels, on UAV based terrain modelling rated 82% at most and much levels, on geo-spatial data creation rated 88% at most and much levels, and on flooding damage assessment and dashboard creation rated 86% at most and much levels. Therefore, the knowledge sharing delivered the good understanding of the representatives of the local organizations towards the flood simulation system. That was the crucial key for them to embrace the system for their flood situation preparedness.

As the activity was conducted to assess whether the respondents were certain to apply the knowledge and skills to flood situation preparedness, 100 percent of the participants were able to apply the gained knowledge and skills to work in their units, 100 percent confident and able to apply the received knowledge and skills, and 100 percent able to disseminate knowledge/ transfer to their agencies. Therefore, it was

Table 7. Results in percentage of after knowledge and technology transfer activities for focus-group public participation

Activities of knowledge and technology transfer	Levels of knowledge and technology comprehension				
	Most	Much	Moderate	Little	least
Knowledge sharing	82-90%		-	-	-
Plan to use the knowledge to flood preparedness	100%			-	-
Measured skills after the technological workshop	100%			-	-
Willingness to cooperate the acquired knowledge and technology	98-100%			-	-
Building cooperation on the acquired knowledge and technology	100%			-	-
Support for use of the system to cope with flooding or other disasters	82-100%			-	-

increasingly convincing that the participants were certain to apply the knowledge and skills to the flood situation preparedness.

For the technological workshop, the results showed that they managed to determine the reference station, to increment the flood level, to set the reference station, and to increment the height of the flood level at least at the moderate level and showed none at little or least levels. That may have led to the assumption that they could use the system at ease and could have had positive implication where the building cooperation was concerned. Indeed, that linked to the fact that 100% of the respondents agreed with the use of the flood simulation system in terms of building cooperation through knowledge and technology exposure, collaboration with relevant agencies, and support for the implementation of the flood simulation system.

It was gathered from the literature review that the weak liaison to serve upper and lower actors indicated the lack of coordination to the need for the process in that every engaging party could participate to achieve successful disaster prevention and mitigation. When the activity was successfully organized, the questionnaire commonly used to extract the required essence should undergo the IOC analysis for questionnaire liability. The contents should not discard the point where community leaders would react differently to different disasters and how their authority, knowledge, and social capital would interact.

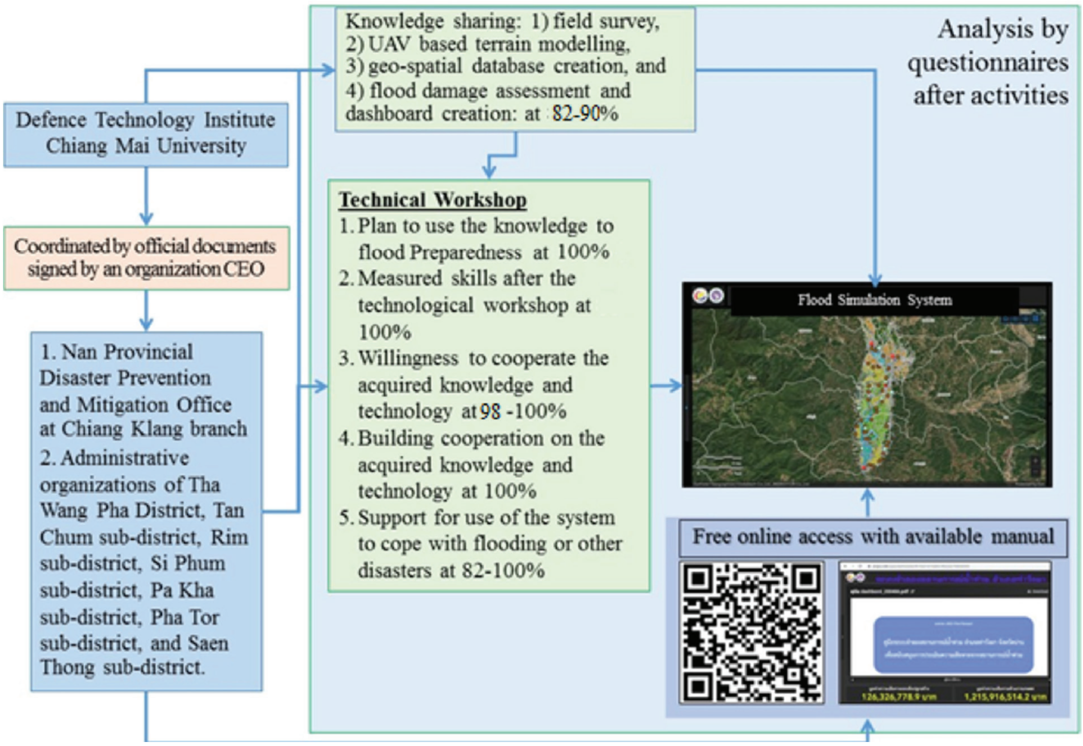

Figure 5. The new process for public participation of local administrative organizations

Thus, all the results summarized above were affirmative that the flood simulation system could be used as the tool among decision makers such as the officials of Chiang Klang Branch and the local authorities in flood situation preparedness and risk reduction. The activities also hugely contributed to the creation of the new process for invited and focus-group public participation of local administrative organizations such as those in Tha Wang Pha District, Nan Province as illustrated in Figure 5. The system was the product previously delivered to the military unit for test and evaluation and used in this current study as the tool for formally coordinated public participation.

The official coordination among relevant agencies and institutes was the key for the successfully organized activities. Official documents signed by organization CEOs often viewed as the enormous document workload but strictly exercised in this study acted as the evidence that all involved parties were formally committed and to act accordingly to arrive at the same goal of public services for flooding situations. The analysis conducted on the questionnaires after the activities played the major role in accomplishing the success of the knowledge and technology transfer activities of the flood simulation system.

A few drawbacks of the flood simulation system were realized and periodically conveyed to the participants while the activities being run. The 2021 data collection especially for the field survey of the construction, buildings and seasonal agricultural products may have carried temporal errors to yield current damage assessment at time of using the simulation system, making the seasonal updates of land use map containing agricultural products necessary and the topic worthy of further investigation. In addition, the water level was mandatory to input each incremental 20 cm interval from the reference station to avoid clumsy online processing of the simulation, making the damage assessment to yield average values at that specific input water level not anywhere in between. The principles of modelling to simulating that involve sampling to projecting may be excusable in this study. In this regard, the participants were aware and reminded early in the knowledge sharing activity.

6. Conclusion and Recommendations

The knowledge and technology transfer was the process adopted to bring the flood simulation system to the door steps of the 7 local administrative organizations in Tha Wang Pha District, Nan Province. The district is the first floodplain with repeated flooding problems to have either directly or indirectly effected 50,519 people. The knowledge sharing and technology transfer via technical workshop were introduced to create the new way for 7 local administrative organizations to represent as focus-group public participation in the flooding situation preparedness. Official documents were central to all the necessary coordination and to have all involved parties committed to the same goal of the local administrative preparedness for flooding situation.

Having the respondents hugely valued good relationships with other government agencies, worked with and through the network of cooperation to cope with the flooding situation, and required the cooperation of many agencies, other local administrative organizations of Nan Province especially those located along both sides of Nan river banks should have the similar and extended simulation system to push the results to a larger extent. Where the respondents vastly agreed with the use of the system for building cooperation through knowledge and technology exposure, required the collaboration with relevant agencies, and encouraged the support for the implementation of the flood simulation system, the extension and suggestion of this best practice should be recommended to other local administrative organizations.

From an insight into the flood simulation system, the UAV based terrain modeling and geo-spatial database creation were technology dependent, and the focus was prompted to the need of the field survey, and flood damage assessment and dashboard creation. The latter two processes had to be equipped with seasonal changes as a result of agricultural and manmade activities. Frequent field survey is suggested in order for the flood damage assessment and dashboard creation to yield accurate and up-to-date results. A complete circle of public participation throughout the simulation process is seen to reflect resilience and sustainability in disaster preparedness and risk reduction. The damage assessment and dashboard creation need to really enjoy high performance computation in order to make the utmost use of ultra-fine resolution of the UAV terrain modelling. The water level being allowed for users to input incrementally much less than 20 cm interval from the reference station will arguably yield even more accurately averaged values, that is, applying finer modelling to achieve more realistically simulating results.

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